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EDITORIALS.

Technical Men and the Industries.—The papers by Messrs. Sabine and Lee, on coöperation between technical schools and the industries, were prepared by them as officials of the New York Central and Pennsylvania Railroads respectively. The papers give, as nearly as may be, the official attitude of the railroads toward the technical school. This attitude is one of friendliness and coöperation. The discussion following the presentation of the papers brought out mainly two points, the relation of conceit to success and the attitude to be taken by the graduate to prevent possible exploitation at the hands of the manufacturers. The general conclusion on the first point was that conceit comprehends two varieties, one in which the possessor has confidence in his ability to handle himself, the other in which he believes himself capable of managing other people's affairs. On the other matter, Mr. Dietz explained the attitude of one large manufacturing company toward the technical graduate, showing that the securing of low-priced, high-grade labor is not the purpose of the apprentice course.

The Mark Hopkins University.—The influence of even a casual remark made about a great educator is evident in the discussion of Director Person's Minneapolis paper. Scarcely a speaker failed to refer to the one-teacher-one-log type of university. If the paper did nothing more than to emphasize the necessity for getting close to the student it is well worth while. But it does a great deal more in showing that wholesale education need not be of the machine type if properly organized. We have the apparently paradoxical condition of getting the educational work so well organized that the machinery of organization becomes invisible. Just as the finest art conceals the effort that produced it, no matter how labored that effort may have been, so the best education is that in which the mechanism is concealed. Director Person tells us how, by scientific management, we may get back to the elemental educational process. His paper is a fitting supplement to Mr. Gilbreth's symposium of last year.

Is the College Making Good?—The article by Mr. Edward Bok in the *Outlook* for August 16 has very properly put educators on the defensive and has aroused lively controversy. This article was based upon replies to the question, addressed to the members of the graduating classes of a number of leading colleges for men and women, "What has the college done for you physically, socially and mentally?" In making the inquiry Mr. Bok enclosed stamped, addressed envelopes for reply. He included several thousand graduates in the investigation.

The results of the canvass, as might have been expected, were disappointing. In the first place, a small proportion of those addressed replied at all. Second, most of those who did respond couched their replies in careless language. Third, the letters showed a lack of comprehension of what education is for, hence their content is comparatively valueless. The general conclusion reached from a study of the above facts is that the college is not "making good."

Is the Technical School Making Good?—Mr. Bok's inquiry did not include many technical students, but a condition which exists in one branch of education is likely to exist in all. On the basis of experience in teaching technical subjects there are several reasons for not taking the results of the canvass too seriously. Of two thousand men students addressed, somewhat fewer than five hundred replied, in spite of the stamped envelope. For a circular-letter "broadside" this is a fair return, particularly as there was no great incentive to reply and certainly no obligation to do so, contrary to Mr. Bok's opinion. The question asked was such a broad one that each student who considered it carefully must have realized his inability to answer it. The question really comes down to this, "How much stronger, more useful and wiser are you than you would have been had you not gone to college?" It is like asking a man who has been out of college some years, "How much more salary are you earning now than you would have been earning if you had not gone to college?" To answer

either question is difficult, although the latter is much more tangible than the other.

This leads to the point, however, that although Mr. Bok's data do not justify his conclusion or, as we see it, any conclusion, the conclusion itself contains much that will appeal to a teacher as sound. We know that the average technical student will not reply promptly to an inquiry and that he will not express himself clearly and forcibly when he does reply. He will even misspell words, leave out important parts of speech and otherwise reflect upon his present and past training. But this, reprehensible as it is, does not mean that his education is a failure any more than does his inability to explain what college has done for him.

The questions that each student should ask himself are such as these: "Am I learning how to attack and solve problems of any nature, technical, literary, social, as they arise? Am I becoming more resourceful, more accurate, more unselfish from semester to semester? Am I getting out of my college work the suggestions which it has for me as to how I can make the most of myself within my limitations?" If the replies are affirmative, well and good. But why cannot these desirable ends be accomplished without the college? Surely every experience in life should be educational in these senses. Just here is where the college comes in as a specialist and its training is designed to secure the desired ends more efficiently than they can be secured in the rush-and-tumble of every day business life.

A carelessly-worded letter from a college student or any one else is simply an evidence that the problem involved has not been attacked by the proper method, in fact the presence of a problem has probably not been realized. If the student will say to himself "Here is a letter which I have to compose and write. What is it for, what shall it contain, how shall the contents be arranged and how can I best express myself?" the chances for a passable result will be favorable. The real fault in students is that they do not look for the problem in

every experience of life and that of the teacher is that he does not sufficiently urge the importance of doing so.

Serving our Fellow-members.—At the Minneapolis meeting President Magruder emphasized the value of this society and of the teaching profession in general as a field for service. At the meetings it is a great privilege to slap each other on the back, exclaiming "How well you look, etc.," but this is not enough to justify our existence. To come right down to solid ground we must do what Professor Scott asks at considerable length in the report of his committee printed below in this number of the BULLETIN. It is inconceivable that there have not been hundreds of interesting little and big developments in the educational field in the past few months. Through the BULLETIN these can be brought to the attention of the membership promptly and effectively. Of course, Mr. Bok's allegations do not apply to us teachers. A little exercise in composition, with an idea behind it, is fun for us.

REPORT OF THE COMMITTEE ON THE IMPROVEMENT OF ELECTRICAL ENGINEERING LABORATORY INSTRUCTION.

The committee appointed at the Boston convention of the Society advises that coöperation between electrical engineering departments is desirable and may be carried on along several different lines.

While a comprehensive schedule of topics might be prepared, and the work might be undertaken in an elaborate manner by committees of investigation and the preparation of statistical and comparative reports, it is believed that more satisfactory results can be secured at the outset by less cumbersome and formal methods. The monthly BULLETIN affords a ready vehicle for interchange of information and ideas. Communications on particular topics at different times during the year may be compiled and edited by a committee before publication. Methods and appliances which have been found useful

will be suggestive to others. The common interchange of new ideas will be stimulating and helpful. The difficulties and problems which confront the teacher may be stated, and the comment and suggestion of others who may have met similar difficulties may be forthcoming.

One of the most important fields for useful coöperation is a standardization of courses in order to save the unfortunate students who transfer from one institution to another the year which it usually costs them to make the transfer. By standardization is not meant equilization, because technical schools may have different objects in view. A tabulation of the various courses of electrical engineering departments, grouped according to equivalents, would facilitate a general comparison between different courses and would facilitate the interchange of students.

Some fruitful topics for brief contributions are as follows:

1. Apparatus for lecture-room demonstration. Description of simple or novel equipment for the demonstration of fundamental principles or of special phenomena. Experiments which will arouse the student's enthusiasm and will appeal to his imagination are particularly desired.

2. Problems and topics for research or special investigation which bring out the ability of the student for independent activity.

3. Coördination between text-books and laboratory manuals, and between recitations and lectures and laboratory practice, indicating methods by which the average student can get the best results from laboratory exercises.

4. Grouping of students in laboratory work, the relation of students in each group, and the scope and methods in the preparation of laboratory reports.

5. Ideals and methods in the teaching of electrical engineering to non-electrical engineers.

6. Description of the arrangement and handling of laboratory apparatus, explaining the purposes and results secured by the arrangements adopted.

7. Courses of general reading, and the presentation and discussion of papers as supplementary to the text-book and laboratory courses.

8. The use of diagrams, pictures, maps, models, and the like in connection with lectures and also for permanent exhibition in the electrical building.

9. Methods of handling students in class-room and laboratory as related to the number of instructors required, particularly in large schools where the classes must be sub-divided.

10. Employment by a school of its own graduates as instructors compared with that of graduates from other schools.

11. Relation of the teaching in allied departments to that in the electrical department, including methods of conference among instructors.

12. Advisability of having examination papers written by persons other than the instructors who give the courses.

13. Impressions of those who have made trips of inspection to other technical schools, giving comments of an outsider, usually to be published without names.

14. Extent to which students should be allowed to use dangerous voltages in laboratory or research work.

15. Desirability of theses. Should they be compilations of information obtained by reading, results of tests of familiar kinds on standard types of apparatus, or of research character? If the last-named, is the aim to make new discoveries or to cultivate research methods?

16. Extent to which the personal qualifications of students can be studied and possibly graded so that they may be advised to strengthen weakness which would prevent them from making successful engineers or commercial men in later life.

17. Wisdom of attempts by technical schools to meet the demand for further training for commercial positions?

18. Value and administration of inspection trips.

19. Best methods of conducting branches of the A. I. E. E. with membership consisting mostly of undergraduates.

Other topics will naturally suggest themselves. In general the object is not to secure lengthy descriptive material, but to

lay emphasis on the reason why a particular scheme is used and on the character of the results attained.

Those who have visited other institutions say they find that features which appeal to them on account of interest or novelty are regarded as too simple or commonplace to merit publication by those who have devised them. If we can adopt a method of publicity which is devoid of formality we can secure the interchange of these items without the labor of travel.

It is recommended that contributions be invited from members, upon topics such as have been enumerated, with a view to their publication in the BULLETIN.

This report is a compilation of suggestions received from members of the Committee either in discussion or by correspondence.

CHAS. F. SCOTT, *Chairman.*
C. F. HARDING,
H. H. NORRIS,
W. I. SLICHTER,
G. B. THOMAS.

REPORT OF THE COMMITTEE ON IMPROVEMENT IN MINING ENGINEERING LABORATORY INSTRUCTION.

It is the sense of the committee (1) that all laboratory work for mining engineering education should be for the purpose of increasing the efficiency of teaching the fundamentals and theories of the basis of the mining engineering profession; (2) that the time of undergraduate work in the laboratory should be devoted to the attainment of proficiency in principles and theory, in the first place; and to the acquisition of skill in manipulation, in the second place and incidentally; (3) that it matters not at all what the details of the equipment may be, provided that it best serves the primary purpose; (4) that the primary purpose of the laboratory may

be accomplished by a considerable variety of different equipments.

Therefore, the committee believes that an attempt to standardize the laboratory for mining engineering education would be unnecessary and undesirable, but that a statement of fundamentals and principles and essential theories might be useful as a guide in the equipment of laboratories. For the purpose of carrying out this plan the committee would recommend the appointment of a new committee on the Principles and Essential Theories for the Undergraduate Work in Mining Engineering.

F. W. SPERR, *Chairman.*
E. A. HOLBROOK,
J. B. PORTER,
H. H. STOEK,
L. E. YOUNG.

SOCIETY BUSINESS.

The Program Committee has, by letter ballot, approved the setting aside of a three-hour session of the Princeton meeting for the use of the Committee on College Administration. The latter committee expects to have several papers by eminent educators as well as its own completed report.

By letter ballot the Executive Committee has approved an appropriation of $25.00 for the expenses of the Committee on Statistics of Engineering Education.

OTHER SOCIETIES.

The Efficiency Society held a very successful convention at Lake Placid from September 19 to 21. The papers dealt with the application of efficiency methods to the individual and to social service. No papers treated directly of educational matters.

The American Institute of Electrical Engineers has just completed an index to the transactions for 1901 to 1910, inclusive. This is a model index comprising 367 pages. The articles are arranged topically and an adequate digest of each is given. The names of participants in the discussion of each paper are also listed with a brief digest of the discussion. Volume I of the index will cover all of the Proceedings up to 1900 and will be issued shortly. Topical indexes are now being printed in the last part of each year's transactions, so that from now on the vast mass of data found in the transactions of the Institute will be readily available.

The National Society for the Promotion of Industrial Education will hold its seventh annual meeting in Grand Rapids, Mich., from October 23 to 25, inclusive. Advance copies of the program can be secured from Mr. C. A. Prosser, secretary, 105 E. 22d St., New York City. Professor L. E. Reber and C. R. Richards and Dean Herman Schneider, of this society, are on the program.

LETTERS TO THE EDITOR.

SECRETARY S. P. E. E.,

Dear Sir: Some weeks ago you referred to me a letter from a young man who wished suggestions regarding the study of scientific management. I sent him the accompanying letter which I trust was suggestive to him.

Yours truly,

HUGO DIEMER.

STATE COLLEGE, PA.

It is my opinion that, while a very good knowledge of scientific management can be gained from books, this book knowledge should be supplemented by actual experience. Such experience can be obtained by securing employment in such works as the Tabor Manufacturing Co., The Link Belt Co., or the Lanston Monotype Company. All of these companies are located in Philadelphia. It would also be very good if you

could take the course to be given to teachers of scientific management under the direction of Frank Gilbreth at Providence, R. I., during August this year.

In our own shops we are arranging to have the designing of machinery and parts to be built in our machine shop to be taken care of by an instructor who has had previous experience in conducting college shop work, and who has lately taken graduate work along the lines of using the machine shop as an experimental laboratory carrying on work with lathe dynamometers. He has also had some experience at the shops of the University of Illinois, where they have been building gas engines. This head instructor will be assisted by another whose duties will include the preparation of and process of route maps, the preparation of detailed instructions, tool lists, specifications of feed and speed and the making of time studies. This assistant instructor has had long experience in shops conducted under scientific management. This experience includes work in the planning department as well as work as a practical machinist.

SECRETARY, S. P. E. E.

Dear Sir: The paper of D. M. Wright which was printed in the June BULLETIN of the S. P. E. E., under the title of "The Revision and Standardization of English Technical Terms," as well as the announcement in *Science* of August 1, 1912, of the recent appointment by President Magruder of a "Committee on Standardization of Technical Nomenclature," induces me to write you in the matter. Before proceeding further, let me say that I think, first, that Mr. Wright is to be congratulated on his interesting and forceful paper; second, that the S. P. E. E. is undoubtedly a most proper starting point or even machine, for working out the proposition; third, I am confident that the committee named will produce excellent results.

But it rather seems to me that the true work to be done along this line is of far greater magnitude than is apparently realized from the foregoing actions referred to, and that the whole

problem needs to be attacked with a better conception of its mass and probably with a differently-designed machine or tool if the greatest success is to be obtained.

Mr. Wright's paper was mainly on the subject of the nomenclature of mechanical engineering. His resolution offered and expressed at the end of his paper was infinitely broader when taken literally and disconnectedly from the paper, but if read as printed, as part of the paper, would seem to indicate that the main work of the committee is to be on the subject mentioned. The committee named, from its small size, would perhaps justify the belief that the breadth and mass of the work such a committee could do on this line were underestimated. For instance, why confine the standardization of technical terms to mechanical engineering? The same difficulties have, for some time, been and now are impressive in civil engineering, electrical engineering and doubtless many other branches or divisions of the profession. If the arguments for standardization hold as good, as they seem to, in one they do in all.

Again, why confine the consideration solely to nomenclature? Why could not the same committee contemporaneously do a great deal of advantageous work in standardizing other units of professional consideration. There are at present a number of societies working through committees toward a similar end—*i. e.,* that of standardizing certain features of engineering science and art. The American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Society of Electrical Engineers, the American Society for Testing Materials, the American Chemists' Society, the American Society for Municipal Improvement, etc., all have committees which, under present circumstances, seem to find it necessary to attempt to establish certain standards in order to proceed satisfactorily with their work, or to perform what seems to them their full duty in the matter, and most of them seem already to have touched more or less on this subject of nomenclature. In such unrelated, or at least non-corre-

lated effort there has been and is, of course, much inefficiency to say nothing of dissatisfaction.

In Great Britain the whole matter of standards has, it seems to me, been more broadly surveyed and far better approached. There, as perhaps you know, an "Engineering Standards Committee" was formed several years ago, and to it all such matters, when they arrive at a stage of sufficient importance, are referred. The conclusions of this committee carry the greatest possible weight and I believe have the effect of law in many cases. The committee is a large one and is composed of several members from each of the national societies supporting it. Sub-committees of the whole committee are naturally appointed for particular subjects, but a great advantage is secured by requiring the consideration and approval of the whole committee to the report of a sub-committee, which has independently digested its subject carefully and thoroughly. And in this way related interests, even if only connected through a few points to the subject of a sub-committee, secure an opportunity to be heard on such and to have their views considered when the subject is before the main committee.

I believe this "Engineering Standards Committee" accomplished monumental work of international value some years ago on the subject of Nomenclature in Electrical Engineering. It is now about to take up the subject of Nomenclature in Highway Engineering, and I, with some others, have been asked, as Americans therein interested, to assist the sub-committee on the subject.

The disadvantages under which we Americans will work are obvious. How much better it would be, not only in this case but also in many others, if an American Engineering Standards Committee existed as a focus to and through which the lines of thought from our different engineering interests and associations could pass.

This subject of nomenclature or terminology seems so fundamental and important that it appears to me that right now the opportunity is offered the S. P. E. E. to start something that

may eventually, and quite probably in a very short time, be productive of enormously valuable results. Taking this particular subject of nomenclature, which seems for many reasons particularly one to be handled by the S. P. E. E., could and should not the Society move for the creation of an Engineering Standards Committee in America, which committee could and naturally would later absorb for its consideration and digestion many other subjects? Such a result must be more efficient than the several and independent activities now going on as above referred to, and the general satisfaction with the results would seem to be naturally greater.

It is perhaps not too late for proper consideration to be had of the points I have tried to make. I should have written earlier and before the appointment of our committee had I not been away until the past few days. I trust the importance (as I conceive it) of the matter may outweigh the delay in my communication.

Sincerely yours,
W. W. CROSBY.

BALTIMORE, MD.

EDITOR'S NOTE: Professor A. H. Blanchard, of Columbia University, another member of this society, has been appointed a member of the United States Committee on "Standardization of Nomenclature of Roads Materials."

PUBLICATIONS RECEIVED.

The Pennsylvania Lines, Pittsburgh Office, has issued a 71-p. booklet, beautifully illustrated, showing the damage by the 1913 flood and how it was met. This bulletin will interest particularly the members concerned with railroad construction and maintenance, but is of general interest to all. The repairs cost this one railroad nearly $1,500,000 and, including damages to stations, buildings and equipment, nearly $1,700,000. The direct property loss to the railroad is estimated at $3,600,000.

Professor A. E. Salazar, head of the electrical department of the University of Chile, Santiago de Chile, has published a pamphlet on *"Funziones Iperbolikas"* and their application to electrical engineering problems. The pamphlet contains 24 pages and is illustrated with dia-

grams and numerical problems. References to the work of Drs. Becker, VanOstrand, MacMahon, Merriman, Woodward, Kennelly and other well-known writers in this field are given.

BOOK REVIEW.

THE ELEMENTS OF SPECIFICATION WRITING. A Text-book for Students in Civil Engineering. By Richard Shelton Kirby, C.E., Professor of Civil Engineering, Pennsylvania State College. John Wiley & Sons, Inc., New York. 6 by 9 ins., vii + 125 pp., $1.25 net.

In this book the author has taken up the elements of contract writing in a concise and simple manner and has given the student an excellent view of the field free from the complications of special or exceptional cases.

The legal principles involved are briefly discussed in Chapter II, while numerous suggestions are made throughout the text as opportunity offers for illustration in connection with specific clauses. The student is cautioned to proceed slowly in writing any but simple contracts until he has acquired experience and become familiar with books on contract law, or better taken a course in the law of contracts. The objects to be secured by the advertisement and proposal are discussed in Chapters III and IV. The composition of specifications with discussions of general and specific clauses fill the next eight chapters, followed by outlines of specific clauses and an appendix giving references mainly to periodicals.

While the text is brief it is constantly suggesting the larger field in a manner to interest the student in further thought and reading even if no outside work is assigned. This is assisted by the practice in specification writing planned by the author to be carried on in connection with the text.

C. L. CRANDALL.

PERSONALS.

Dr. Ernst J. Berg, formerly head of the electrical department of the University of Illinois, is now actively at work at his new post, Union College, Schenectady, N. Y., where he is professor of electrical engineering. He is closely associated

with Dr. C. P. Steinmetz, who this fall assumes the title of professor of electro-physics. Drs. Berg and Steinmetz have long been close associates in professional work and their new educational relation will be not only pleasant to them, but of great value to the great educational fraternity. Dr. Berg has promised an article for an early number of the BULLETIN on the subject of "Mathematics for Students of Engineering." He has in progress two books on the "Theory of Electrical Engineering."

Prof. Thomas T. Eyre, formerly of Purdue University, has been appointed assistant professor of mechanics and head of the department of mechanics and hydraulics at the Case School of Applied Science.

Mr. Maurice B. Greenough, formerly instructor in mechanical engineering at Rhode Island State College, Kingston, R. I., is now instructor in civil engineering at the Case School of Applied Science, Cleveland, O.

President C. S. Howe, of the Case School of Applied Science, who has been absent for fourteen months on leave of absence, has returned.

Mr. J. F. Lewis, formerly instructor of mechanics of materials at Pennsylvania State College, State College, Pa., is now assistant professor of electrical engineering at Lafayette College, Easton, Pa.

Mr. F. W. Marquis, formerly of the railway engineering department at the University of Illinois, Urbana, Ill., is now professor of steam engineering at the Ohio State University, Columbus, O.

Prof. Dalton Moomaw, formerly assistant professor of mechanics at the Case School of Applied Science, has resigned to take up county engineering work in Cleveland.

Prof. Geo. H. Morse, formerly head of the electrical department of the University of Nebraska, is now consulting engineer for the Mutual Electric and Machine Company and is located at Wheeling, W. Va.

Mr. E. L. Shepard, formerly instructor in civil engineering at the Michigan Agricultural College, East Lansing, Mich., is now assistant professor of civil engineering at the Clemson Agricultural College, Clemson College, S. C.

Mr. S. L. Simmering, formerly graduate fellow in mechanical engineering at the University of Illinois, Urbana, Ill., is now at the Pennsylvania State College, State College, Pa.

Mr. C. L. Svensen, now of 166 Main St., Medford. Mass., has resigned from the mechanical engineering department at Tufts College, Mass.

FUNDAMENTALS OF EDUCATION.*

BY F. W. SPRINGER.

Asst. Professor of Electrical Engineering, University of Minnesota.

XI.

Modern Trend in Science and Education.

One can see into the future by looking through the present from a viewpoint in the past. The changes in science, business, engineering, education, and even in religion, have been so rapid and are now changing at such a rate that it is highly important to note the direction or the trend of these changes in considering such a problem as that of education. History, if read in terms of one's personal experiences and observations, and not merely learned by rote, is a splendid aid in developing that foresight as necessary in planning for future action as in education.

A few hundred years ago one might have been hung for insisting that the world was round. Everybody "knew" then that the world was an enormous disc covered by a dome-shaped sky, studded with stars for the edification of man. Nowadays, if a man insisted that the earth is flat he would be laughed at, not hung, because people have grown so accustomed to having their opinions and ideas reversed by new

* Continued from the May Bulletin, p. 616.

discoveries and inventions that they have become more tolerant. It addition, scientific knowledge, and the training leading to it, have instilled a respect for nature's laws and for the truth in general. This scientific truth- and cause-seeking attitude of mind is quite general, and in direct contrast with the hazy and empirical ideas about many things of a few hundred years, or even decades ago. Newton discovered the law of gravitation; Watt applied steam in the generation of power; and Volta, only a little over one hundred years ago, produced the electric battery, the first device for generating an electric current. Today, science and its applications dominates almost every phase of human life.

Since these discoveries it has become possible to read news concerning events that happen on the other side of the world, hours before they happen by our time. It is merely a matter of a few weeks for anyone to reach almost any part of the world, and he may be at all times in communication with any other part. Steam, gas, water and electric power have displaced man power, multiplying the productiveness many times. Automatic machines, driven by the forces of nature, tirelessly repeat the ideas and processes of the inventor, who stands by devising new machines which will displace more hand work and brain work and still further add to the luxuries of life. It is the spirit of the age to seek means of directing the forces of nature in order to overcome friction, inertia and gravitation.

The daring of the modern scientific mind is startling. They now conceive, for example, an atom to be a micro-miniature system quite similar to our solar system, with infinitely miniature satellites whirling about a central particle or "sun."

Gravitation, which may be either a push or pull, acting between us and the earth, in fact, acting between every particle of matter in the universe and every other particle, is now being explained by electro-magnetics, as is also light, heat and electricity.

The tendency is to explain all the regularity of observed

phenomena which we call, laws of physics, chemistry, etc., in terms of one unknown law or thing, and the belief is increasing that there is really one *Great Law* of the *Universe,* our little laws of science and engineering and life being merely different phases of this Master Law.

Scientists are even attempting to produce life from inanimate matter by chemical combination. Why not? If they succeed they even then cannot explain what life actually is. We have no sixth sense which enables us to detect electricity, directly. There is no absolutely satisfactory definition of it, yet billions upon billions of foot-pounds of electrical energy are generated and used as desired every year. No one doubts that there is such a thing as electricity, or that it operates under perfectly precise laws.

Many people now think of life as a universal thing which may appear anywhere in its elementary forms, when the conditions are just right, as simply and surely as geometrically perfect crystals of salt appear in a glass upon the evaporation of a salt solution.

We are astonished when serious and sane scientists estimate the age of this earth and attempt to tell the story of the meteorites that come to us out of infinite space. The scientific process of the birth of a world is up for serious discussion. It is no wonder that some call this daring search for the secrets of the universe, sacreligious presumption.

It was formerly philosophy and discomfort and hardship. It is now science, engineering, laws of nature and luxury. Man has learned to direct the forces of nature in and about him to his own convenience to a marvelous degree, and there are whole fields of science in sight and as yet unexplored.

It is interesting to speculate as to how this modern life, with its great demands upon brain and nerves, may affect the race. We know that a change in environmental pressure results in new wants, different kinds of repeated actions which in turn result in new habits or in a variation of habits, and lastly that habits become transmittable as composite racial characteristics.

If muscular work becomes less and brain work and power more necessary, will the physical strength be displaced by brain strength to the point where brain power may decrease owing to physical weakness?

If we were to draw a vertical line, representing the average potential brain power of today, and another vertical line to the left of the first along the line of time, say of 10,000 years ago, would the second be much shorter than the former? If the second vertical line were assumed to be a little shorter, that is if the brain power of today were a little greater, and we drew an inclined line across the top of these verticals, intersecting the base line in the distant past, could we obtain, perhaps, some idea of the time required by the human race to raise its intelligence above that of the lower animals?

Whether or not the brain power of the highest type of man of 10,000 years ago was much less than that of the present, it is certain that man has advanced greatly in some of those things which distinguish the brute from man. The great difference between the human mind and that of the lower animals is the ability of the former, not only to *direct the laws of nature in his interest but to transmit accumulated knowledge.* Surely in these two things tremendous strides have been made in 100 years and the greatest rate of progress has been made in the last 50 years. Whatever the relative brain powers of the past and present may be, the present civilized races have infinitely greater racial efficiency than those of the past. We may conclude that civilization seems to be as much a matter of training as of brains.

The improvement in the efficiency of a race may undergo wide changes in one or two generations. In other words, a serious mistake in the training or education, whatever the prime cause, may mean the fall of a nation. Germany, and especially Japan, are excellent examples of increased racial efficiency. In 1850 Japan had practically everything to learn about civilization. Now that she has effective engines of peace and war, she is said to be civilized, and we are attempting to

answer the question, "Does modern efficiency improve man's morals, and does civilization really mean much more than racial efficiency?" Many think not.

Modern success thus seems to be very largely a matter of mental and physical training or education and coöperation. Whether our people are to be mortgaged or conquered by another race depends almost altogether upon our educating machinery, taken as a whole, which is entirely in the hands of the older generation.

We must remember that conditions and laws of survival of the fittest now tend to eliminate a somewhat different class than formerly. Physical strength counts for little now, unless physical strength and size tends to be accompanied by greater brain power. Even numbers are futile before cleverness and invention. Brains and trained brains and concerted action count for nearly everything in the contest for supremacy among races as well as among individuals. The race that can build and operate the most efficient and effective engines of peace and of war takes such things as it may wish for its needs or comforts.

The ability of a race to take what it wants is one of nature's measures of its right to survive, but any race that takes too much is also taken care of by nature's laws. Gluttony and luxury are even more effective than starvation and misery in the eliminating process.

The contest among races and nations, as well as among individuals, for the best places and opportunities involves leader selection and survival of the fit. It is offensive to some people to mention the forces of nature which operate to select the fit among lower animals as the same forces which apply in selecting the fit and trained among races and men, but they are the same forces. One should not forget that if man with his superior intelligence may go higher than the lower animals, the same mental strength also enables him to go lower. Just as long as man remains fallible, we shall have policemen and prisons, commercial warfare and starvation, executions and wars, whatever may be the desires and opinions of millenium

chasers. Man's fallibility, however, may be decreased by proper education and by aiding nature in producing those fit to be educated.

A buffalo bull leads his heard. Sooner or later a younger, stronger and more fit leader appears, defeats the former leader, and takes command. There are other means provided by nature for selecting the fit cows and calves.

England is the present leader among nations and determines the trend of civilization for millions of people who in return pay well for the service rendered. Germany aspires to the opportunities and honors now enjoyed by England and perhaps by others. When the time comes for the selection of a new leader, it will not be a dehorned contest, whether the trial consists of actual combat or merely a display of strength in commerce or in the field.

Among the lower animals usually only those means of offense and defense provided directly by nature are available. Among nations and men the elementary forces are seldom used directly. Man's fitness to lead, to rule, and to take those opportunities necessary to his survival and progress, is generally determined by his ability to direct the forces of nature, whether it be by battleships, battalions, strategy, commerce, or what not. Hence, the education or training as a whole, of individuals and races, is almost always the determining factor, and it is not ideas, theory and culture only, but rather the training that results from personal experience that counts most in the inevitable contests of life.

Largely through the influence of scientific discoveries and their applications, conditions of life have so changed during the last few years that *competition* is everywhere, in everything, not only between those of the same county and of the same state, but also the competition of every nation is at the door of every other nation. Distances are annihilated. Machines directed by men and employing the forces of nature do our work and make luxuries available to all. Efficiency of human effort has thus gone up at a tremendous rate within

the last fifty, twenty, ten, and five years. One man with science and machines supplies the wants of thousands. Hence, our school system must be such as will develop a high vocational efficiency because of inter-racial or international competition, if for no other reason.

Competition, very largely, is back of railroad wrecks, steamship disasters, oppression of the wage earner, bribery of law makers, etc., etc. The individual, or group, or state or nation, that is behind in efficiency and courage carries the burdens to the comfort and convenience of those more up-to-date.

Scientific discoveries are rushed into practice, often without a thorough trial, without men trained to properly put the new ideas into practice, or to operate them. Low factors of safety are resorted to, to cut down the costs. When one cannot succeed without taking a chance one runs whatever risk is necessary for the sake of *success*. Few people of to-day make a serious complaint if they have *just missed* a railroad wreck or a steamboat disaster, although they make many threats of vengeance if through a deviation of a few inches or seconds something serious does happen.

Other things being equal, the race that can and does apply or direct the laws of science, or of nature, with the greatest precision, with the greatest safety and with the lowest safe "factor of safety" will win.

Educational Trend.

In view of the application of science and the need of skilled workmen and trained leaders, there is little wonder at the pressure to introduce manual training, trade courses and engineering courses into high schools. There is also little occasion for surprise at the tendency to vocationalize academic courses.

Twenty years ago high school courses were administered on a strictly cultural basis with Latin and Greek and Mathematics occupying the chief positions. A little later modern languages and science began to displace the classics, because the former were considered more useful.

Recently manual training, which we may call vocational culture, has begun to displace the modern languages and claims are being put forward that hand work may be taught with real cultural results. In any case, the stand is taken, that of two evils too much vocational work would be better than too much cultural training. In other words, it is better to develop ability to satisfy wants not yet developed than to develop artistic tastes for which there is no earning provision.

There is no doubt but that the average Latin and scientific high school graduate makes a stronger college student than the *present* English-manual training student. However, the difference may be due to differences in the students, the teachers and teaching methods rather than due to the difference in subjects. *In any case, the many must have vocations,* while only to the few is Latin, for example, a necessity.

In the near future we shall undoubtedly see the manual training in the present cultural high schools develop into separate industrial high schools which will occupy the same relative position to engineering colleges as the present high schools do to academic colleges. Some of the material now taught in engineering colleges, which comes within the sphere of common use and observation, will be taken up by these industrial high schools.

Twenty-five years ago the place for a telephone would have been on the lecture table of advanced applied physics. Today three-year-old babies are held up to the telephone by their mothers. The telephone is now certainly within the sphere of observation and use of children, and there is no reason why certain phases of telephony should not be taught in technical high schools. The boy of fourteen can make a good telephone with little difficulty. Let him make it and use it to talk with his neighborhood chum. He will then be prepared to study higher harmonics, Pupine coils, etc., in college. The same thing applies to a thousand and one other things and will apply more and more as scientific applications are made, their theories digested and made ready for junior observation and study.

While the greatest apparent change will take place in the development of technical or industrial high schools, important changes will also be made in the cultural high school by teaching so-called cultural subjects with directly utilitarian objects.

The above changes will have some secondary results of great moment, for example, masculinization of the education of boys between fourteen and eighteen, finally resulting, probably, in men teachers for boys to some extent beginning with six years.

The greatest obstacle in the way of developing the new work is the lack of properly trained men teachers of the right personality. There are not even any schools or at least courses for properly training these teachers. Further, in a great many instances, the school control is still in the hands of the old-school type of men who either do not realize the direction of modern trend, or cannot adjust themselves to it for other reasons.

The same cycle of changes has been going on and will continue to go on in the universities. Twenty years ago, the vocational or professional schools were side issues, the engineering courses were few and weak, and engineering students were simply the flannel shirt contingent. Things have changed somewhat. To-day some academic colleges are hoping that they may be allowed to give the first two years of college work as cultural preparation for the professional courses. But this does not seem to be the answer to the problem. It might be better, perhaps, if the academic colleges started vocational courses of their own, in civics, economics, history, chemistry, geology, etc., and deliberately set about to prepare students for immediate and efficient usefulness on leaving college.

The professional schools are tending to the taking over of the preliminary college training for their courses in some lines because a student who has selected a vocation does not care to mark time vocationally for two years, even for the sake of culture.

It would not seem that the tendency to require a bachelor's degree as entrance to some of the professional courses would

long hold, unless the academic part of such a vocational training were modified to fit the demands of mature life for each particular vocation. To illustrate, engineering-English, language, mathematics, etc., might be taught engineering students by teachers who have at least an engineering perspective, if not an engineering training, in order to assist the student in working cultural ideas into his vocational sphere immediately, and combining these ideas as habits with the other elements which make up the sphere of knowledge of the engineer.

Industrial high school courses, or junior engineering courses, appear to have already started in Minnesota. They have begun by introducing really serious and effective courses in all kinds of shop work, in shops equipped with real machinery. There are also courses in various kinds of drawing and drafting. These are the elementary courses in an engineering training. It is only a question of taking another step, then another.

The German industrial high schools started years ago as night classes in mechanical drawing. They are now turning out well-equipped *junior engineering graduates* who have learned many of the phases of engineering, such as some of those now taught only in engineering colleges in this country.

Just as soon as forceful engineering graduates who like boys and teaching get hold of our industrial schools, it is believed they will start something in the way of real mechanical, electrical and civil engineering courses for boys between the ages of 14 and 18. Boys would swarm into these courses. It is to be hoped that school boards will soon seek engineering graduates as teachers of certain subjects in the grades and high schools.

One trouble with endowed and private industrial schools has always been that they start with the idea of teaching trades, and they end up by teaching graduate work. It is very difficult to hold a faculty down to a fixed grade if they are given the liberty of advancing. Good teachers are ambitious and many of them desire to climb the whole length of the ladder with the pupils. But, if the industrial schools are managed

by regularly elected school boards who have in charge also the other high schools, the industrial high school will be held in its proper field, because the practical common sense of Mr. Taxpayer is not liable to allow an expensive college of engineering, or an academic college, to be duplicated in every city in the state. One expensive engineering college, with research departments, can turn out all the highly trained engineers and *engineering teachers* the state can use or can afford to pay for.

The industrial high schools, and the "Fortbildung," and trade schools with them, must be within easy reach of the student. Hence we may expect the same distribution of industrial high schools in our cities as in the case of the cultural high schools. It is quite likely that industrial work will eventually be given in separate buildings from the cultural courses, since form must, sooner or later, follow function, and that the night school work will decrease with the increase in number of "fortbildung" and trade school graduates.

The division of high school work into cultural and vocational courses will undoubtedly segregate not only the industrial and professional classes to some extent but also the sexes, since the training that fits the sexes respectively for modern life must necessarily be different.

Co-education is a tradition in the United States, yet the extremists who would teach the girls and boys tatting, and boys and girls turning, to obtain all the advantages of co-education, are disappearing, and, while co-education is impossible under the present social conditions and traditions in France, and in Germany, it will remain, no doubt, in America for many years. Co-education will, however, be unquestionably modified by vocational segregation and by the introduction of men teachers in the grades, first as manual training teachers, then in athletics, military drill, citizenship, and mathematical and scientific subjects.

Co-education does not seem to retard the solution of the problem of education at the present time. The girls, having obtained the right to take the same courses as the boys, and

having demonstrated that they can carry off most of the school honors, now want girl's subjects.

The tendency to teach cooking and other domestic subjects in both American and foreign schools, instead of in the home, the increasing number of boarding schools, college dormitories, and the like, all point to leaving more and more of the bringing up of the children to the schools in the next generation. What the parents neglect or refuse to do, the State must do. However, if the domestic science courses, now so popular, are as successful as claimed, and hoped that they may be, we may expect domestic instruction to be again given in the home, and not expect the pendulum of all home training to swing clear into the school system for any great length of time.

(*To be concluded.*)

PARALLELOGRAMS OF ENGINEERING CULTURE.*

BY J. C. RALSTON,

Consulting Engineer, Spokane, Wash.

It has been said that "engineers are not made, they are born. The schools cannot make engineers, they can only help to so train that their students may develop great capacity for becoming great engineers." The school, worthy and necessary as it is, is, after all, the workshop of the sculptor or the atelier of the artist, the place where the rough cast is first modeled or where the monochrome sketches are outlined. The sculptor must go to the quarry if his work is to be enduring and the artist must go out into the broad fields of nature if his production is to be given a place in the Luxembourg of master-

* An address on engineering education delivered before the Congress of Engineering and Scientific Societies recently held at Spokane, Washington. The Congress was made up of the local members of the Premier Societies of the U. S., represented in Montana, Idaho, Oregon, Washington and British Columbia.

pieces. The school is, therefore, the directing agency, the student is the concluding agent. The latter must take up the great work where the former left off. If the student does not take up this post-collegiate work, and bring into it high personal and professional ideals, supplemented with rare commonsense judgment, he must not blame the school if failure follows. More than this, he must augment his ideals with the fundamental proposition that his chosen profession is, of the six or more great professions, the second in rank, the profession of teaching ranking first.

Engineering education on the technical side is a broad, searching and well-ordered field. I am not, however, concerned with the curricula of engineering schools in this paper, nor with the technical studies outside the schools, but with the sadly-neglected, though highly-important division of the personal and non-technical side. It is not a question of linear variables, physics, nor the resolution of forces, of which happily there is a copious and well-digested supply; but it is rather one of the parallelograms of culture and social responsibility, that which should be the subconscious endowment of every engineer. I desire to touch only a few of these fundamentals, in order to bring out discussion at this meeting. My outline is therefore purposely cursory, suggestive and brief.

Within the limits of individual ability, each student gets his technical training more or less complete. Do the engineering schools require at matriculation or before graduation a knowledge of, or does the engineer afterwards train himself on, cultural lines, the essential art of pleasing and forceful address, political economy, sociology, et cetera? I fear not to the extent that they should. What, if anything, does the engineer take, or do the schools give, on the history of engineering, ancient or modern; and what suggestion does he get of the romance of that subject when translated by a man of vision?

It may be answered that there is no such worthy work to be found, nothing in the librarian's record of scientific history comparable with the histories of the other professions,—noth-

ing of broad, constructive vision. Suppose that is true. Yet I cannot imagine a better training than that the student in college, or under his own candle, extract from universal history some of the great facts of engineering as exemplified in ancient, medieval or modern constructions, from the pyramids to the Assuan Dam, or in military conquest, from Salamis to Port Arthur, or in colonization, from the Argonaut of mythology to the Reclamation Service to today. Who was the engineer that made possible Sherman's march to the sea? Perhaps history but faintly records such personalities. If so, is the profession blameless? Nevertheless, without the resourceful engineering abilities of a once well-known engineer, Sherman's March could never have been made. We engineers of the west may ask ourselves who were the engineers of the early Pacific railroads; what were their problems, and what was their influence upon national development? What of the synthetic romance between the age of the "Stepping Stones" of primitive man and the new Quebec Cantilever of superman? What of civic centers, from the Acropolis to the designs of Daniel Burnham, or of water-supply engineering, from the days of the Roman aqueducts to the inverted siphons of the Catskill supply? And so *ad libitum* into the dreamland of engineering.

Technical training and experience presuppose a well-ordered mind. One is the irresistible corollary of the other. How much better qualified, then, is the engineer to become a man of affairs than are members of the other professions who take a prominent, even conspicuous, place in the society of men! And if the engineer adds culture and grace of speech to an already well-ordered mind, his social, professional and financial standing is sensibly advanced. The habit of vision, the quality of estimating the value of his every structure, however modest each piece of work may be, as it relates to human advancement, is worthy and should be cultivated. Though the smallest work is but a single stone in the Pantheon of Civilization, it is a stone nevertheless, without which the struc-

ture would be incomplete. If we do not idealize, we become idolatrous. Without vision we become visionary.

This theme was epitomized by Mr. Jesse M. Smith, Past President of the American Society of Mechanical Engineers, when he said, at the dedication of the Russell Sage Laboratory of the Rensselaer Polytechnic Institute, "An engineer, however diligently and effectively he may do his work in his chosen field, who never tries to look beyond his own circumscribed horizon, can never expect to become a great engineer." Culture and vision, then, are the open sesame to a position of influence in our respective communities, in the state and often in the nation. Without them we must remain hermits among the professions.

Turn to the bulletins of the engineering schools of the land and note that the requirements for entrance embrace, in the final analysis, little more than an ordinary course in English. This plus a technical course makes, or is supposed to make, a professional man. Alas, that's all it does make. What foundation is there out of which may be evolved the man of affairs? What deep, abiding suggestion is given the student on which he can and will seek long and diligently, during his active days of study, and continuously thereafter, for that laudable and worthy aggrandizement which it is but human and proper to seek? Perhaps the pedagogue may some day answer. I fancy that the practising engineer is the one who will answer. I do not criticize so much the professor as I do the engineer. There is, generally speaking, a lack of coöperation between the two. Each is too often self-centered and self-sufficient. The former, in the eyes of the latter, is often foolishly theoretical; while the latter, in the eyes of the former, is grievously unacademic. Like a giraffe, each one continues to bump his head against the moonbeams and refuses to browse on earth.

National ideals, according to Professor Junge-Hermsdorf, should be given three basal divisions. It has not been suggested however that the engineer is a dominant factor in any of the divisions.

Social ideals fall to the state—because the state's concern is with public welfare. But public welfare is a synonym for public health, and in this the engineer is the inner and the outer barrier; *vide* water supply, garbage disposal, sewerage and sewage disposal; roads, bridges and traffic; the theory of assessments and benefits; water fronts, harbors and terminals; boulevards, ringbahns and parks. In these, the fundamentals of social ideals, surely the engineer is dominant.

Artistic ideals are generally left to the leisure class—the promoters. But in these ideals the engineer must be considered as of the academy. Much that pertains to civics must receive the stamp of his judgment or the influence of his personality, if he has any. Good judgment will lead him in the design and execution of his works to secure the fullest artistic advantage of environment, and when structures and environment are made to fit each other the highest requirements of art are satisfied. If he is a leader, as he should be, or is a man of affairs, as he ought to be, he will make his influence felt in society, art commissions and similar bodies seeking municipal improvement. If he's an ass, he'll merely play politics to hold his job.

Industrial ideals fall almost exclusively to the engineer. The first consideration herein involves a fundamental axiom, namely, just as the elements of national wealth, such as mineral and agricultural lands, forests, railways or industries, are withdrawn from the possibility of private though regulated ownership, so is the amount of industrial capital curtailed, and national development restrained. Second, stagnation due to monopoly, whether in industrial output or control of labor, is prevented by that form of regulation which is controlled, not by political or selfish considerations, or utopian nostrums; but by economic principles.

The first of these considerations involves nearly the entire technology of engineering, and *predetermines* the *primary interest* the engineer should exercise in politics. The second consideration presupposes the eternal vigilance and the highest intelligence of the executive engineer.

Who, then, shall meet and shape the final industrial policy of the nation, a policy as yet unformed and therefore unhampered by traditions? Shall it be the politician or the engineer? The former is already an active, assertive agent; the latter, I sometimes fear, is a bit atrophied, emasculated by his own inertia.

I have in mind a successful and popular public utilities corporation in Spokane which is controlled in every department by engineers, and it is the envy and wonder of all similar corporations in the West. When corporations cease deifying the so-called practical man, and avail themselves of engineers, their ills can be pathologically treated. Why? Because the practical man has no ideals, while the engineer has, and he regards each piece of work a stone, as I said before, in the Pantheon of Progress.

Industrial practice should always coöperate with scientific endeavor. The story of the locomotive read backwards from the finished machine to the lathe, to the forge, to the qarrying of the ore, embraces a sweeping technology. From the gold in the mine up to the mint, to the United States Treasury, and to a national banking system is a technological romance.

How far are we students of sociology and of labor conditions? Perhaps I am approximately correct when I say that on the average sixty per cent. of the cost of all engineering works represents the cost of labor; forty per cent. represents applied technology. Why should not the rare art of understanding, directing and handling labor be some sensible part of engineering education? More than that, surely some knowledge of the evolution of social conditions as affected by labor and by the trend of supply and demand should be understood. The engineering work on the Panama Canal is an example.

Engineering practice in the West often demands a wider range of faculties than in the East. The pioneer state of our development does not require the same degree of specializing; while the diversity of the problems falling to the individual engineer compels him often to spread out over a thinner surface than otherwise. In proportion as the problems of the

western engineer are diversified, so must his education and abilities be broader.

Again, the technical man is presumably an educated man. If he does not speak and write like one, suspicion at once falls upon his technical ability, said Mr. J. L. Harrington in his admirable paper on the Need of Good English. His plea is that the engineer should educate himself in order that he may become a man of affairs. He points out that ordinary English breaks down when it is called upon to state technical subjects accurately and with precision. The engineer should therefore have an extraordinary command of English, a wide vocabulary, and should be a master of synonyms. A well-ordered mind is always reflected in well-ordered language. If not, something is amiss. The versatile comma and semicolon are vastly more important than their microscopic size portends. For the omission of a semicolon a federal court once awarded damages to the sender of a telegram. A broker wired his client asking if he, the broker, should buy a certain stock. The principal answered "No; price too high." The telegraph company omitted the semicolon, the broker made the purchase and the principal lost an amount which the court found to aggregate $50,000.

Advancement as an engineer, as a man of affairs, or even socially, is sluggish to the engineer of poor or halting address. Interviews or letters, if poorly expressed, often defeat their purpose; while the writing of reports and specifications requires peculiar skill.

Is the engineer as loyal to his brother engineer as the lawyer is to his co-worker? I have known engineers, generally small ones to be sure, and happily fast reaching the vanishing point, who emulate the cave-dweller by carrying around a big stick for their usually more successful competitors. Curiously and righteously enough such sticks always warp into boomerangs.

The lawyer is accounted fairly successful who wins sixty per cent of his cases. The forty per cent which he loses he tells his clients was lost because the court or the jury was prejudiced, and yet he continues to retain his clientele at a

sixty per cent efficiency. The physician is successful if he succeeds in about the same ratio, for in those cases which he loses Providence of course intervenes. This is another case of possibly sixty per cent efficiency. The theologian has never yet produced a certificate of specific performance.

On the other hand, if in a whole life-time of successful professional work, the engineer loses a single structure, he is everlastingly damned by the entire public and, I say it tearfully, by some of his own profession. Yet he has delivered an efficiency of ninety-nine per cent. Is this fair play, and isn't the engineer partly at fault because he hasn't always been that forceful man of affairs which carries a compelling recognition to the public mind? And yet when we shall have passed through the valley-mists of detail and climbed into the mountain tops of performance, is it fanciful to hope that we shall discover Aurora herself folding back the clouds and revealing a dazzling sun rising upon a world of fairer play?

PART II.

PROCEEDINGS OF THE SOCIETY.

The following papers were presented and discussed at the Minneapolis meeting. Brief written contributions, if sent to the Secretary promptly and if accepted by the Publication Committee, will be printed in an appendix to Vol. XXI of the PROCEEDINGS, now in press.

ACADEMIC EFFICIENCY.

BY H. S. PERSON,

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The purpose of this paper is to present for discussion the problem whether the principles of scientific management, as applied in industrial operations, can be applied in the business of educating young men. It is not concerned with the field of engineering education, for with that I am not familiar; nor with the field of higher education for administrative service, in which I am engaged; but with college education in its broadest aspects, education in the arts, humanities and sciences. It is not concerned, furthermore, with the purely business phases of college education—the construction and management of the plant, repairs, upkeep, purchasing, etc., for these activities are in my judgment unquestionably subject to the application of the principles of scientific management. It is concerned with the business of academic instruction, its personnel, equipment and methods; with formal instruction of the class-room and with that informal instruction which operates outside the class-room, the instruction imparted by an educational institution by its atmosphere and the opportunities for educative experience presented by the society it creates and directs.

Objections to Scientific Management in Education.

Mr. Cooke's *Bulletin No. 5* of the Carnegie Foundation, on Academic Efficiency, has brought out within the few years since its publication numerous denials of the applicability of the principles of scientific management to educational work, especially to the work of instruction. I have had occasion to examine a large number of these criticisms of the report and

find that most of them are simply statements of opinions unsupported by data of experience or investigation, unsupported even by argument. The few that do present argument present *a priori* argument only and all essentially the same *a priori* argument. It runs somewhat as follows. "The product of an industrial plant is a material thing, capable of precise measurement qualitatively as well as quantitatively; the product of an educational plant is the scholarship, culture and manliness of its graduates, attributes quantitatively and qualitatively immeasurable. The processes of an industrial plant are mechanical and subject to exact and known laws and subject to precise variation in application with reference to their effect; the processes of education are functions of the contact of minds and personalities. The material of the industrial plant is matter, capable of as precise quantitative and qualitative measurement as is its product; the material of the educational plant is the human mind and human nature, intangible and immeasurable, and never the same in two individuals. The principles of the organization and administration of the one cannot be therefore the same as those of the other."*

Insufficiency of these Objections.

It seems to me that argument of this kind does not settle the question but merely opens it. It embraces a number of assumptions which sound true, and in a large way are true, but which should be subjected to investigation and experiment. Since my interest was aroused by analysing these opinions I have observed numerous facts which raise doubts of their validity.

In the first place, they assume that instruction is imparted by personal contact of instructor with student in the way it is done in the ideal college, a log with Mark Hopkins at one end and a student at the other. Now I am free to state that I know of no more efficient educational organization than this, as to personnel, equipment or method. I wish I could afford

*"Academic and Industrial Efficiency," by H. S. Person, in *The Dartmouth Alumni Magazine*, Vol. 4, No. 4, Feb., 1912.

for each of my children a Mark Hopkins and a log; I should then not be concerned with material, method or organization, and I should not fear for results. But I cannot afford it; neither can a democratic society educating its youth on a large scale afford it. Furthermore, the supply of Mark Hopkins is limited. We are educating and must educate our youths in groups, and the moment education by groups becomes a fact, that moment personal contact between instructor and student diminishes, in some instances, as in lecture courses, to almost nothing, and organization becomes a necessity and a problem. Efficiency in organization must make up for diminished personal contact; or, to put it more accurately, efficiency in organization must *restore* personal contact.

Functionalized Educational Operations.

With education in groups must come, if we would restore the Mark Hopkins efficiency, functionalized educational operations. Mark Hopkins with his one student on the log could instruct formally, supervise the study of his student, talk with and influence him "out of the class-room," be his social influence. The non-formal instruction of a Mark Hopkins under these circumstances is perhaps the greatest education. But in our colleges and the undergraduate departments of our great universities, with one, two, three, four and even five thousand students, with the diminution of personal formal instruction has resulted practically the disappearance of informal instruction, the contact outside class room between instructor and student with its advice, encouragement and inspiration. To meet this situation organization must arise and restore something of the equivalent of what has been lost. The many functions of the one man educating one student must be replaced by the same functions, distributed one each among many educators instructing large groups of students.

Social Problems of Large Colleges.

Furthermore, large educational institutions with large aggregations of students, most of them away from home for

the first time, have social problems which the one-man-one-student institution cannot have. Students in masses, like other people in masses, are subject to a mob psychology which causes the break-down of conventional rules of conduct and conventional ideals. Unquestionably one of the valuable educative factors of an educational institution is the broadening of the mind manifested in a moderate reconstruction of habits of conduct and ideals developed in the narrow environment of home life; but it seems to me that in many instances this reconstruction, when undirected, takes place too rapidly, goes too far, and particularly goes too often in the wrong direction, so that the student when he leaves college has to experience still another adjustment to the society he enters. An educational institution is a trustee representing the parents of every one of its students, and as student aggregations increase in size should by organized mechanism attempt to direct the formative mental and moral influences working outside the classroom but within its proper jurisdiction.

Applicability of Scientific Management to Education.

It appears, therefore, that the *a priori* arguments against the applicability of the principles of scientific management in instruction, both formal and informal, are grounded upon false premises; that they premise a Mark Hopkins, a log and one student, whereas our educational institutions are great aggregations instructed in groups; and that in so far as personal contact between instructor and student tends to diminish, organization must become more complex if efficiency be preserved. As organization becomes more complex the principles of scientific management become more applicable.

I propose now to consider in detail some of the principles of scientific management and some of the educational problems to the solution of which they might be applied, which have come under my observation. I shall consider only a few of the main principles of scientific management as conventionally classified.

Educational Science a Necessity.

A principle of scientific management is that its methods are the methods of a true science; that in attempting to solve problems of industrial organization and management it employs the method of elaborate investigation, experiment, correlation of data and analysis. One would expect that an educational institution, in the laboratories of which is kept burning and handed on from generation to generation the sacred fire of scientific method in research, would employ these methods in attacking educational problems. But as a carpenter is said to have the most defective sidewalk, and a lawyer to have inefficient counsel if he is his own client, so are educators least scientific in attacking problems of education. Inefficient investigation, incomplete presentation of facts, irrelevant arguments and snap judgments are most common. This situation is not to be attributed to incompetence. The absence of functionalized responsibility is the principal cause. Instructors are overburdened with duties of formal instruction and preparation for it, and cannot enter with enthusiasm into the performance of the function of solving educational problems. They look upon the latter function as one to be got out of the way as quickly as possible and with as little interference as possible with study and formal instruction. The point I wish to make here, however, is that, whatever the reason, educational problems are not attacked and solved by scientific methods. I recall the story of a committee report on an important matter which had been referred to the committee by the faculty of a college. The committee reported "inexpedient to legislate," and without giving reasons for its conclusion explained that it had investigated the problem as existing in the principal other institutions and had spent all of six hours on it! No wonder the committee could not present reasons after a six-hour investigation! Incomplete and unscientific investigation and an inefficient report on the matter referred to the committee deferred five or six years the adoption of legislation which later marked a step forward in the educational efficiency of that institution.

The Need for Statistical Study in Education.

In educational institutions, as in some industrial plants, there is a horror of so-called unproductive labor. Industrial concerns are learning that this kind of labor is oftentimes the most productive, and are increasing their cost-accounting, statistical and informational forces. Educational institutions might well follow in this respect the most advanced industrial practice. The principal records kept by educational institutions relate to marks and attendance, a simple ledger account with students. Every educational institution should have a force of statisticians accumulating and correlating data which might guide the institution in determining what policy to pursue. Labor of this sort, engaged in applying scientific methods to the investigation of educational data, would be most productive by increasing the productivity of those who actually meet and instruct students.

The following are some of the problems which might be scientifically investigated by such a statistical bureau. What is the best working size of a class-room division for each subject taught? What is the proper length of a recitation period for each subject taught; should some occupy one, some two and some three units of time? Which would be more efficient, three recitations per week in one course, or six, or five? Is there a season of the year in which best work is done by students, and should assignments be adjusted accordingly? Is it possible to establish standard assignments (say in modern language instruction) varying according to the text read and the part of the text being read at a given time? Is it better for all students concerned to meet and instruct them in chance-assembled groups, heterogeneous as to scholarship, or in groups determined by scholarship? Is it possible to determine standard pedagogic methods for teaching different subjects and to acquaint instructors with them? These are a few of the many detail problems of efficiency which confront educators. They have not now data on which to base judgments, and they have not the time to accumulate and correlate such

data. Only an organized statistical bureau in each institution can properly perform this function.

Functional College Organization.

What I have said about functional investigation of educational problems suggests the general application of the principle of functional organization, another principle of scientific management. There should be functional teaching (the activity most nearly specialized at present), functional administration (discipline), functional advising and functional supervision and guidance of non-classroom educative influences. Today the obligations of the instructor embrace practically all institutional functions except general administration. I have read in *Popular Science Monthly* during the past two years numerous articles asking that the teaching force of each institution be made to assume that function also! The result of placing on the shoulders of the instructing force the burden of the performance of so many functions is that none is performed efficiently, not even instruction itself as efficiently as it might be. I have shown that the function of solving educational problems is performed inefficiently. In administration there is a tendency to handle students at arm's length, so to speak, by general inflexible rules of administration, and not to consider each case of discipline by itself, to be decided according to the particular circumstances and rules of equity. Contrary to the opinion of many, I believe that the larger the number of functions imposed upon an instructor, and consequently the greater his burden, the more impersonal becomes his relationship with students. He is compelled by the very burden of duties to perform them through regulations which operate impersonally. Some educators argue that teachers should never give up their administrative duties because it is they alone which keep the instructors in touch with students. It is, on the other hand, these very duties which shut the instructors off from personal contact with students; which makes the contact they seem to have unreal and gives them a false view of students. An instructor

who does nothing but teach, but has leisure for informal intercourse with students, can learn to know the student as he really is, and by the power that knowledge gives him can "reach" the student and inspire him in the class-room.

The Advisory Function.

One of the great functions of the teacher in the Mark Hopkins-one-log-one-student type of college is the advisory function. If I were to send a son of mine to such a college, I should expect the largest educational results to come from the advice "out of school" about all sorts of things—informal talks about literature, science, sports, ideals, conduct, how to study, how to play, what things are worth while, what things are not worth while. The large modern educational institution has lost the power to perform this educational function, but it has not lost the responsibility, and it will some day be held to account. Theoretically the instructor performs this function, either informally on his own initiative or formally through an advisor system, but the performance can be perfunctory only. In the first place, it is one of the several functions too many the performance of which is left to the instructor. In the second place, few men are temperamentally capable of being disciplinarian and sympathetic advisor also. In the third place, in the cases of those few instructors who are temperamentally capable of being both disciplinarian and advisor, there are in the student mind obstacles to advisory relationship, for the student, if he knows his advisor to be disciplinarian, assumes that he cannot be sympathetic advisor, and this state of mind at once defeats the establishment of advisory relationship. In the fourth place, many instructors are not broad-minded enough to be advisors, and the function should not be entrusted to them.

I consider the advisory function one of the most important responsibilities of an educational institution, and it should be entrusted to functionalized advisors, picked men. I have seen many college students' careers made relatively inefficient because of lack of counsel at critical times. I have also seen

careers made relatively inefficient because of unwise counsel given. How many college graduates do you suppose there are, who wish that they could have had many talks during their college years with some large-minded, sympathetic man, who could have told them what things are worth while!

It is a principle of scientific management that the determination of *how* be entrusted to specialists and not left to the workman, thereby eliminating the waste of misapplied effort. The advisor in an educational institution would save much wasted energy of students by relieving them of the necessity of deciding the *how* in situations which they have not the experience to decide safely.

Results of Functional Organization.

Functional organization would deprive the individual instructor of many of the duties he now performs, but it would leave him free to make himself more efficient in his primary function—instruction. It would enable the institution to perform, and the student to receive the benefit of, a wider range of efficiently performed functions than is possible at present.

Other principles of scientific management have been suggested by what I have already said. To apply one principle makes necessary application of all the others, for the body of principles of scientific management is an organic whole; each principle is but an angle of view of all the others. Functional organization involves wise selection of men (instructors, advisors, disciplinarians, etc.), wise selection of equipment (pedagogical methods and apparatus), and wise classification of material (students; according to scholarship, natural ability, preparation, health, temperament, etc.). It requires these wise selections and, what is more significant, it, and it alone, makes these selections possible.

Scientific Management and Rewards.

Scientific management has discovered that men can be inspired to more efficient self-instruction, more efficient following of instructions, and to higher levels of energizing, by

reward according to productivity, in some tangible form and immediately. An immediate, tangible, practical reward for efficiency is unquestionably a powerful force. Is it not possible that something more could be made of this principle by educators? The reward of being permitted to play on a football team, provided he is not below a certain rank in scholarship, has inspired many an athlete to better scholarship than he would otherwise have shown. The reward is practical and immediate. On the other hand, I have had seniors tell me that they would have tried for Φ B K, had the reward for hard work not seemed so far away to them as Freshmen.

Scientific Management and Academic Freedom.

One response to suggestions that efficiency in instruction could be increased by wise application of the principles of scientific management is the criticism that it would diminish academic freedom, suppress the individuality of instructors and deaden the spontaneity of the class room. I insist that, on the contrary, it would increase academic freedom, bring out the individuality of the instructor, and enable him to bring before his students more of the power to arouse and inspire. The teacher who is relieved of the burden of too many functions would find himself freer to investigate widely, think deeply, know life and form individual judgments. It would enable him to find the way of and time for self-expression. The erect figure, the keen eye, the intense earnestness, the precise statement of fact and principle, the wise choice of interesting and illuminating illustrations, characteristics which, in addition to scholarship, make the great teacher, would continue to exist and to arouse and inspire.

Discussion.

Professor A. E. Haynes: After an experience of five years as an undergraduate and nearly forty years of teaching, about thirty-seven of it in college, and after a cessation of the steady strain of the class-room for a year and a half I think that I am prepared in some degree to act the part of a just critic since,

through all these years, both as student and teacher, I have been deeply interested in education, including both the subject matter and the methods of instruction.

At the close of my undergraduate work, in a public address at Commencement, I stated, as a result of my previous five years of experience and observation, that I was satisfied that too many studies were required of the student to make him efficient in any. Since that time new studies have been steadily added to our curricula until they have become so overcrowded that they defeat the fundamental purpose of education. Too many studies in too little time produce confusion and lack of confidence on the part of the student. Too many lines of thought tend to distraction; they lead one nowhere; they do not develop the mind. The power of abstraction is the most important, the finest fruit of right education; it is not born of confusion; it is the child of painstaking, thorough, clear-headed, logical mental development. Intensiveness is not the child of extensiveness.

The curricula of our schools, from the kindergarten to the university, are crowded beyond all reason and all hope of producing the best results. To be able, parrot-like, to recite rules and formulæ is not education any more than walking thru a botanical garden makes one a botanist. It is that which the student masters that makes him a student; going through books does not necessarily educate him. There is a great difference between one's going through a book and having the book go through him.

Scholarship is not measured so much by its breadth as by its depth. The disciplinary and the cultural value of a course does not depend so much upon the number and kind of subjects in the course as upon the way in which it is taught and studied.

Why is there a great cry for efficiency at the present time? It is because education has been made a stuffing process, instead of a process of evolution. The teacher is not so much to blame for this state of affairs as is the poor system under which he is working. The time properly spent on one-half of the

number of studies which are now required would lead to a higher efficiency, to a thoroughness and to an independence in thinking not now possible. Our whole system of education needs some heroic surgery, and it should be subjected to a major operation. Have we the courage to begin this work? If so I hope we shall not be slow in doing our best.

In conclusion, may I quote from that excellent work by Hon. John M. Gregory, "The Seven Laws of Teaching"? These are worth writing in every class-room, in letters of gold.

1. "A teacher must be one who knows the lesson on truth to be taught."

2. "A learner is one who attends, with interest, to the lesson given."

3. "The language used as a medium between teacher and learner must be common to both."

4. "The lesson to be learned must be explicable in terms of truth already known by the learner—the unknown must be explained by the known."

5. "Teaching is arousing and using the pupil's mind to form in it a desired conception or thought."

6. "Learning is thinking into one's own understanding a new idea or truth."

7. "The test and proof of teaching done—the finishing and fastening process—must be a reviewing, a re-thinking, a re-knowing, and a re-producing of the knowledge taught."

This book and "Watt's on the Mind" were a great inspiration and help to me in my active teaching and each is worthy of a careful reading and re-reading.*

Principal A. L. Williston: Regarding the proper number of subjects to be taught we can very easily make some kind of an investigation to find what are the best methods of developing young men. At one time it was my duty to have to assign a special program to every student who got into difficulty with the regular course at The Ohio State University. As an ex-

* The first of these books is published by the Congregational House, Beacon Street, Boston, Mass.; the second by A. S. Barnes & Co., Chicago, Ill.

periment I tried to determine how many subjects that type of student could carry to advantage. And four years of study I found they could carry to advantage not less than three subjects and not more than five. A comparison of the number of subjects taught in the different years of the course in the various colleges of engineering shows results in harmony with that conclusion.

The four broad principles of scientific management as applied to engineering are very simple. The first is, by some method of unprejudiced observation, to determine what is the best way of producing the thing you want to produce. Surely that principle is applicable to education. The second is to find by test, by competition if you please, what men are best capable of doing the things as they ought to be done. Surely we can find out in some way who are the individuals who can teach by the process that we have determined to be the best. The third is to devise a method of teaching them how to do it in the proper way. That can be done but is not done in the teaching profession. We could have people who would help our younger teachers learn how to teach well, if we knew what the best methods were. The fourth is to make it really worth while for the people who are to do the work to do their very best. To a limited extent only are we doing this.

Professor H. Wade Hibbard: The history of the introduction of scientific management in the industries entirely parallels the need of the introduction of scientific management in teaching. The necessity for the introduction of scientific management in industries exists because of the increase in the size of the industries. There has, therefore, been a need of a reversion to type, namely a reversion to the small industry where only a dozen or a score of men were working intimately together to turn out the best product. We have heard it stated here this morning that the ideal university is Mark Hopkins, one log and one student. I believe that, as in the industries, scientific management has enabled the big plant to remain big but to revert to the type of the little plant, so scientific management principles in teaching will enable us

to revert to the Mark Hopkins-one-log-one-student type of university.

Dean F. L. Bishop: I have had some interesting experience in regard to the number of subjects required in the engineering curriculum and remember very distinctly the pleasure (?) I had in taking fourteen final examinations at the end of one term at the Massachusetts Institute of Technology in Boston. In looking through the engineering catalogs at the present time one is struck with the fact that there are now practically only four or five subjects taught. At that time there were really only four or five but they were all split up into little branches, with a different instructor assigned to each. Each instructor held his special examination and each had his own methods of teaching. Today we are bringing these little subjects together under general heads.

I must disagree with Professor Person regarding the log with Mark Hopkins on one end and a student on the other. A student educated in that way today would be absolutely useless to the community unless the modern Mark Hopkins happened either to be a practical politician or a practical engineer. As for educating an engineering student in that way, to do so would be to render him worthless to the community for many years after graduation. But that system has gone. We are not so much interested in developing engineers as we are in developing individuals so that they may be of the greatest service to the community. If a student is not taught in his years in college that he is to be a part of a great community in which he is to live and that he must contribute to the welfare of that community he certainly cannot serve as a good citizen after he graduates.

Dean C. M. Woodward: From my teaching experience I have had demonstrated how efficient a man can be with a reasonably small section of students. The increase in the size of our institutions ought not to have diminished their efficiency because the number of thoroughly efficient teachers should increase as rapidly as the number of students. Unfortunately it does not. As dean I sometimes advised gradu-

ates of the engineering school to go to schools more completely equipped than ours for graduate work where there were superior teachers and ony a few students. The teacher who knows what every single student before him is doing, knows just where he stands in a subject, knows the difficulties which he is meeting and, almost before he opens his mouth, what questions he is going to ask, he is the man who can do efficient work with his students and no other can.

A teacher wrote me not long ago stating that he had a class of one hundred and fifty in descriptive geometry. Just think of a hundred and fifty students listening to a lecture on descriptive geometry! The teacher never asked a question of the students and he never met an individual student. He was obliged himself to solve every problem brought before him. I wrote him thus: "Good Heavens, how can you chew up all that food for them to swallow?" This teacher had a half-dozen young men to look over the drawings that were made by his students, and they may have told the boys whether these were right or wrong, but the man who lectured to them didn't know about it. Now that is not the way they do business where business is done well. For example, I went into the counting-room once with Mr. Armour to see where his business was really done. We went into a large room where the employees were set off in sections, each under a leader. He pointed out several $10,000 men and stated that each one was responsible for his own department. In every department was an efficient man, one for every big task. In no other way can administration be efficient. That is the way in which universities should be run, whether they have five thousand students or only fifty. They should be officered proportionately.

President A. Ross Hill: I am interested in the problem which is under discussion as I suppose nearly everyone in university administration is, and more particularly because I have always kept in mind the problems of teaching. The great problem in teaching is to develop in the student the power to think and to do, and the inspiration to think and to do. Now that power can only come by solving problems, and

not by the assimilation of facts as a result of solutions made by other people. It is perfectly clear to me that an efficient organization for educational purposes must reduce numbers to a reasonable point for personal teaching. I cannot go so far as the author of the paper, if I understand it correctly, in saying that educational organization will lessen personal instruction. Education, or teaching I should say perhaps, is a social function, and man is a social being. No man who has personality to do something more than to stick to a class-room is at his best at one end of a log. He must come face to face with a reasonably-sized body of students in order that the inspirational force of his life and of his thinking may be felt by them. But we do not need to reduce the situation to an unsocial unit. We can keep our classes at a reasonable size and get the greatest efficiency.

Our faculty at the University of Missouri demands a teacher for every twenty or twenty-five students, particularly in the largest classes. The classes, of course, should run smaller than that, but when one has to go to the legislature for appropriations he finds it rather difficult to get the members to think that an allowance of ten students to a teacher does not involve a tremendous waste of money to the state. So much for the organization and the size of classes. I think we must keep both the class-room and laboratories at the point where the teacher gives the problem and the student tries to solve it, but where after all the teacher makes the student solve the problem instead of solving it for him.

Now as to organization in some of these other directions. There are notions of scientific management talked about these days that I cannot follow with great clearness. For instance where there are three or four professors and instructors in a department, I am not able to see how we are going to have one man devote all of his time to classroom teaching, another to advisory functions and another to the administration department. I am not sure that the author intends that, but it certainly seems to me that, in the average institution represented in this society, each teacher would have to take upon

himself several functions. Furthermore I am not sure that by labelling a man an advisor for the student you are going to get the best results. Now in nearly all of our coëducational institutions we have had some experience with the person known as the advisor of women. For this post we require a woman who would be an advisor anyway, otherwise labelling her as such is useless. One must select a person whom the students would naturally select as an advisor. I am not sure that we are going to be able to direct that phase of organization along the lines of the paper to the full extent advised except in very large institutions.

One point brought out in the discussion of the number of courses interests me particularly. I have had a good deal to do with the accrediting of high schools. It is quite customary in most of the states of the northwestern country for the accrediting colleges to insist that the high schools shall confine their students to about four subjects. At the same time those institutions are often teaching their own students six courses. As the student progresses, his work becomes easier and usually it becomes more effective by reducing rather than increasing the number of courses. And furthermore it seems to me that he can, in these subjects, get new points of view with reference to the fundamental courses. It is not necessary to revise the whole curriculum in order to introduce a new idea or to take advantage of a new discovery. A little conservatism, or a little return to former conditions in connection with the number of courses as well as the number of students, would be desirable.

I would say, in closing, that I think the engineering professor has a much simpler problem in teaching, provided he has correspondingly adequate facilities and an adequately large staff, than the academic teacher. The great defect in academic instruction is the lack of motive to secure good results. Now the engineering professor has a much simpler problem in this respect. We look to our engineering schools to furnish the finest types of educational efficiency that are to be found.

HOW CAN THE COLLEGES AND THE INDUSTRIES COOPERATE?

BY IVY L. LEE,

Executive Assistant, Pennsylvania Railroad Company, Philadelphia, Pa.

You have asked one who is not an engineer to give you suggestions as to how as teachers of engineering you can produce better results. I can, however, possibly qualify for my task in the manner of a candidate for the judiciary in one of our western states, who was urged for election upon the ground that he would make a most excellent judge because he had no preconceived notions of the law.

Though without direct personal experience in either the employment or training of technical men, I have enjoyed the opportunity of frank consultation with many of the higher officials of the railroad system with which I have the honor to be connected. I feel, therefore, that I cannot do better than essay the presentation to you of a composite of the views of these men of wide experience and great breadth of view.

Relation of Theory and Practice.

The college is both a training school and a laboratory. The industries of the world not only look to you to train men who can take up the work of directing and guiding great enterprise, but to a constantly greater extent industries are looking to you to solve their broader problems. When President Taft wanted a man to report on what should be the proper system of charges on the Panama Canal, he sent Prof. Emory R. Johnson, of the University of Pennsylvania, to make the inquiry. Some of the finest work in the study of the transportation question is being done by Prof. W. Z. Ripley, of Harvard. The astonishingly able accounting analyses of Prof. Henry C. Adams have been of priceless value to the Interstate Commerce Commission.

Right here, however, I would direct your attention to the point brought out in a conversation I once had with Mr. W. M. Acworth, the distinguished English railway economist, who, after returning to London a few years ago, from attendance upon a meeting of the American Economic Association, made this observation:

"I was surprised, hearing the college professors discuss the transportation question, to note how little they really knew of it. They understood the theory, but not the practice. And later, discussing the subject with railroad presidents, I was astonished at their lack of breadth. They understood the practice, but few knew the theory."

And that, gentlemen, leads me to the chief thought I wish to present to this gathering. The demand of industry is for men who understand both the practice and the theory.

Faults of Technical Graduates.

Let me be concrete. It is the experience of Pennsylvania Railroad officers that graduates who come to them from technical schools are deficient in three general particulars:

1. Lack of practical experience and judgment.
2. An idea that they are far superior to the rest of mankind; and
3. A certain narrowness of mind, inculcated through a too exclusive attention in college to mathematics and theoretical science, and a too great neglect of those broader subjects, such as political economy, history and general literature.

With your indulgence, therefore, I will make a few suggestions as to how these deficiencies may be met.

How Practical Experience May be Gained.

The question of practical experience might be remedied by the man serving two or three years as a machinist prior to going to a technical institute. Of course, this is not feasible in a large number of cases, and the man must get his actual experience after he starts regularly to work. But the college can implant in his mind certain sound fundamental ideas. A man

who has had a good engineering education and has absorbed commercial ideas will make a good commercial engineer. One who is a theorist and scientific man only, with no commercial ideas, will make a good investigator, and possibly a good man in a test department, especially when engaged in scientific research; but even a good test-department man requires some little idea of business, because test-room questions are not settled on quality alone. The best quality for the same cost is the real question at issue. The man of great value to an industry is he who does not merely attempt to follow a theoretical ideal, but who adapts his theories to the actual limitations of the moment, and secures the best practicable result.

Attitude of the Graduate Toward His Work.

Men leaving technical institutions should be made to have a thorough understanding of the fact that they are necessarily almost completely lacking in a real knowledge of the practical application of the principles they have been studying. If a student can be trained by the time he completes his college course to have real openness of mind, he will be well on his way toward success when he leaves college. Young technically educated men leaving school should, at the start, forget that they are men of scientific training, and tackle work precisely as do other workmen, knowing that when they have mastered that part of their education, the time spent in doing so will not have been wasted.

While it is not expected that technical men entering railroad shops shall have to consume as much time on menial or trivial work as those not possessing such advantages, nevertheless, to regard time spent in the shops as time lost in the pursuit of their true vocation is a very grave mistake, and results in many technical men not being advanced to positions in which they manage other men.

It is of the greatest importance, too, that students be impressed with the human elements in all industrial work, that is, they must realize that whatever their college education may have been, they are of very little real value until they have

acquired something which few colleges teach. Too often young men come from our colleges with the feeling that they know too much to be told anything by men who have not had a college education. By assuming such a stand they close the mouths of men who could and would give them very useful information.

A beginner in the practical end of any line of work should be taught beforehand that college education is not everything, and that results can only be accomplished through other men. Therefore, he must get the viewpoint of other men before he can secure that sympathy from these other men on which his success as a manager will depend. In doing this, he will get much misinformation, which he will know to be such, but this knowledge he should keep to himself. We see all around us men holding the highest positions, who have come up from very small beginnings, with no apparent advantages. Yet we find that these men have their business at their finger tips, because they have been through all of its grades. The feeling that the possession of an education relieves a man from the necessity of going into these details has resulted in many men becoming nothing but technical advisers to carry out the wishes of other men who thoroughly understand the details of their work. Such merely technical advisers never share in the great rewards which come to the men who combine a mastery of both theory and practice.

Importance of Fundamental Principles.

It is of prime necessity, of course, that a man who is trained to practice engineering shall have a good engineering education. Successful men in railway engineering work must necessarily be familiar with the laws of nature, and the fundamentals of mathematics. This information can be obtained, however, outside of technical colleges, and the man who obtains his information in this manner, by the necessarily more concentrated application on his part, is generally a better engineer than a large percentage of college graduates, Many competent judges believe that technical courses in the majority of the colleges lay too much stress on details. If more

time were spent on the study of fundamental principles, it would result in developing more resourceful men. Some of our officers, in advising young men, have suggested to them that they devote their entire time to the study of mathematics, physics, chemistry, English and one foreign language, and not take up any particular branch of engineering. A student who is well grounded in the above studies can take care of any proposition which will come before him. His resourcefulness will be developed by reason of his being compelled to work from principles rather than trying to fit the problem before him to some particular detailed case which he has learned in his engineering course.

Many of our officers hold the view that the best shop work for college men is that which can be obtained during the summer in the various shops where actual work is done, rather than having the time of the student taken up by the more or less imitation shop work that is done at some of the schools. The most valuable part of shop experience to a student is the coming in contact with men and absorbing their experience.

I asked not long ago the man who, I believe, is conceded to be the greatest expert in this country in railway electrification, to tell me what he really learned in college. His reply was, "I am inclined to think that the most valuable asset that I brought out of my college course was the habit of studious application to the job in hand, rather than a finished knowledge of any subject. In the final analysis, the technical student has only time to acquire a fairly good grounding in principles of engineering. The college trained man, however, has an immense advantage, after he obtains some experience, over the non-technical man in being able quickly to grasp the relation between the theory and practice and to apply correct principles to practice.

Adaptation of Men to their Tasks.

I would urge that you not only see to it that students receive a broad general education, but that they be made to see that it is of great importance not to be in too big a hurry to commit themselves to a particular life work. College pro-

fessors can be of great value to their students, and also to industries, by advising men frankly as to their limitations, and also as to their strong qualities. The principles enunciated in Prof. Hugo Münsterberg's remarkable book, "Psychology and Industrial Efficiency," will, I believe, receive more and more application as time goes on.

Young men are frequently placed in positions for which they are entirely unsuited, while if they were moved to other positions more adapted to their make-up, they would often prove successful. Some of the very best men in certain departments in our shops at Altoona can never go higher because there is nothing for them to do in general railroad work. In some of these cases no other men on the road could fill their present positions as well as they do. The only thing for such men to do is to leave the railroad and seek positions with concerns that can afford to pay more for the particular kind of ability which these men possess.

Social Service for College Men.

So much for suggestions as to how colleges can the better equip men for taking their part in building and directing our industries. You have all noticed, however, that this is a day of social service. Never before were so many men being called for to act for the people at large in the control of industry, and particularly transportation. The Interstate Commerce Commission has just advertised for a large number of engineers to assist in the pending federal valuation of railroads. Never did a situation more strikingly illustrate the need for men with practical training. If the proposed valuation is carefully and wisely made, it will do great good. As Mr. Thomas F. Woodlock said, in a most illuminating article in the New York Times Annalist of June 23, "Practical confiscation—partial at least—of property actually invested in railroads will be quite possible by 'valuation' if the public is determined to do it, or if the 'valuers' are permitted to run riot among the technicalities." It is an occasion when practical men are needed, men capable of seeing facts as they are, and not with reference to any theories or past prejudices.

So men are being demanded for work with public service commissions, in colleges as teachers, in University settlement and municipal health work, in city governments, and in all those capacities where men can serve their fellow creatures. This is one of the hopeful signs of our times, but this is a period of great unrest. Many strange economic and political theories are being preached. It is a time when our young men should see that things cannot be always as they should be, but that our duty is to make them as good as we can.

Railroad managers for instance would be delighted to equip every mile of road with automatic block signals, to make every car of all steel, to remove all grade crossings, and otherwise to avail themselves of every device to insure safety. But this cannot be done without the necessary money. So in all things, it is well to "hitch our wagon to a star," but to be sure also that the connecting rope is long and elastic enough to let us keep the wheels on *terra firma*. We cannot go through life on an aeroplane. The manager of every industry would be glad to allow his employes a short work day and to surround them with every comfort and luxury. But here again are limitations which must be regarded and which it is of particular importance to have deeply imbedded in the minds of the men you send out into the world to work and to direct the labor of other men. Amidst all the efforts for social betterment and for adding to the general welfare of man we are forced to realize the old-fashioned doctrine that, in the long run, men can reap only as they sow. I leave with you, then, these lines of Kipling's:

"From forge and farm and mine and bench,
Deck, altar, outpost lone—
Mill, school, battalion, counter, trench,
Rail, senate, sheepfield, throne—

"Creation's cry goes up on high
From age to cheated age;
'Send us the men who do the work
For which they draw the wage.'"

HOW CAN THE COLLEGES AND THE INDUSTRIES COÖPERATE?

BY EDWARD D. SABINE,

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The subject of coöperation between the colleges and the industries is altogether too great to be treated in all its aspects in one paper, especially by one whose experience has been no broader than that of the writer. Therefore, I shall attempt only to illustrate a few points that have occurred in my own experience as a railroad engineer.

Relation of Railroad and College.

In dealing with the coöperation of the railroad and the college the first idea which presents itself is that the railroad as a unit cannot deal with the college. The principal divisions of the railroad are the construction, operating, traffic and financial departments. These are all coördinated by and subject to the executive. Each of these departments is subdivided. At the present time the principal connection between the college and the railroad is through the engineering division of the construction and operating departments of the railroad.

The writer, having spent his railroad career in engineering and construction, will not attempt to consider the relation of the other departments to the technical school. There is an opportunity for the college-trained man to become useful in this department sooner than anywhere else in the railroad. The opportunities for promotion are great, and it is not necessary that he remain strictly an engineer as has been shown by the careers of the numerous men who have entered railroad service as rodmen and who have attained high executive positions. This is well illustrated in the career of the late Mr. A. J. Cassatt, of the Pennsylvania Railroad lines, who com-

menced service as a rodman and who attained a position worthy of the efforts of any man.

There are several ways in which the connection between the railroad and the engineering school can be broadened. I believe thoroughly that a railroad man should be 'captured' as young as possible and that he should stick to railroading from the very beginning. This, of course, does not mean for a young man just out of college to step immediately into a position of any great responsibilty. The fact that he cannot do so tends to make the young graduate turn to fields where the immediate rewards are larger, although the final goal is not nearly as attractive. The writer believes that one of the best ways of attracting the undergraduate to railroad work is by a system of volunteers.

Volunteers in Railroad Organizations.

The field office under my charge employs on an average of twenty-five men, divided among inspectors, line- and grademen and clerks. For several summers past one volunteer has been received into this office. His pay has been very small, the idea being that he would receive in experience more than the value of the time which he contributes to the office. This volunteer is called upon to do the work of a regular chainman, working with different parties and under different conditions, so as to cover the various phases of the work which is handled by the field office. He is required to help the other chain-men to keep the instruments properly cleaned, to do his share of errands and work of this nature. He is also, however, given the opportunity to do some real work and to learn the importance of even the humblest member of an organization who does his work properly and with due regard to the safety of others as well as himself. One young man who thus volunteered for one summer did so well that the following year we were able to use him as a regular inspector. A second found work with another railroad immediately after graduation and the writer has been informed that he has gone ahead faster than the average graduate. It would seem that a sys-

tem could be worked out by which the railroads should take a number of volunteers into their service for the summer months to the advantage of the men, of the schools and of the railroads. Of course, it is absolutely necessary that the men who are picked as volunteers are earnest and thoughtful and are desirous of following railroad work after graduation.

Excursions for Students.

This system of volunteers can well be supplemented by arranging excursions for the undergraduates to view various pieces of construction work. These excursions should not be handled as if the undergraduates were consulting engineers and called upon to report the progress of a job, but rather to give them a conception of the actual meaning of engineering work and of the responsibility which falls upon every engineer who has anything to do with construction. The volunteers should come from schools near the location of the work upon which they are employed, so that excursions can be handled from the same schools, and so that these excursions can be supplemented by lectures by the men in actual charge of the work. These lectures should, preferably, be given previous to the excursions, in order to give the students an idea of what they are expected to see and what to observe. This will also give the engineering officials an opportunity to get acquainted with the rising generation, so that as openings come in their departments they will have men lined up who can fill them. At the same time, the contact between the instructors and the men who are actually working cannot help but be beneficial to all concerned.

Need for Letter-writing Ability.

To my mind, one of the most discouraging features of present-day technical training is the difficulty of getting a clear and definite letter of application from the average recent graduate. I have expressed this to various instructors in technical schools and suggested that students be required to

write letters of application, which the instructors could criticize, and have offered to go over some myself and explain in what ways these letters were deficient. My remarks have always been listened to, but my offer has never been accepted. It would seem as though the schools should take advantage of a concrete suggestion, or at least show the man making the suggestion the courtesy of explaining why it is not feasible to adopt it, which brings me to my second suggestion and that is, that the way to coöperate is to coöperate.

Keeping the Teacher Inspired.

There is a great prejudice among many men active in industrial life against the college professor. This is due chiefly to the old-time notion that a professor is a dried-up man who works in a laboratory and takes no interest in actual work. This impression is fostered by such an incident as I have related. Those who come in contact with the really great instructors know better, but the younger men who do the detail work of instruction do not make as good an impression. Let these young men come into the shops and out on the job and see the men who are doing the work. Let the instructor who graduated five years ago go and confer with his classmate who is inspecting masonry on a big dam, and in turn let the inspector drop into the classroom now and then. Assure us who are in the work that we are welcome and we will come. We will be glad to call on you the instructors and rub elbows with you. We alumni want to help make the years of college of the greatest value to the students, but we must feel that we are welcome or we shall stay away.

Discussion.

Dean F. L. Bishop: In Pittsburgh we are located exceptionally well for studying railroad work. We have prepared the outline of a course in mechanical railway engineering, under the direction of Mr. D. F. Crawford, general superintendent of motive power of the Pennsylvania lines, who has devoted a

great deal of time to its development. The young men who take this work will do coöperative work, not only with the Pennsylvania lines, but with the Baltimore & Ohio and the Lake Shore and various other lines. This course will, I think, be somewhat different from the railroad courses offered in other institutions, in that it represents exactly a railroad man's idea of what kind of education a young man should have. Mr. Crawford has twelve thousand men under him, including a great many engineering graduates, so that he knows what is needed in the way of preparation for railroad work.

Professor F. W. Sperr: It seems to me absurd, with our age and experience, to seriously consider that a youngster of between the ages of eighteen and twenty-two can get a finished education in any course. But what should he know? I asked one of our most successful mining managers a few years ago the following question: "After your experience as a college graduate in mining engineering, as a professor of mining engineering, as a practicing mining engineer and as a manager of one of the largest mines in the country, what do you think that young fellows contemplating going into the mining business should be taught?" He unhesitatingly answered "To think." He said that when he was in college he rowed and he *thought* rowing, but that while he studied physics and mining subjects, he did not *think* them. After he got out, however, he had to do some thinking. And he has to continue to think.

At the College of Mines we have a field course in surveying, including some railroad surveying, enough so that the miners can, for example, lay a spur track. Yet I always tell the students that if they could understand the principles from books without using instruments in the field we should not go to the expense of giving them the summer course in surveying. In all of our work our problem should be to teach the young men to think and, if I caught the drift of the paper correctly, that seems to be just the difficulty with the college graduate, he has not learned to think of the things that he has got to do. He

has learned to think in football, rowing, baseball and other games, but not in the things that he has got to do.

Dean C. M. Woodward: I enjoyed Mr. Lee's paper and consider that the third part is a splendid answer to the question raised in second. He showed exactly how the engineering graduate can avoid the so-called "big-head." He should be taught not the commercial details of the day but the everlasting principles which will be the same to-morrow, next year, a hundred years hence. I attribute the "big-head" that young graduates often have to the fact that someone has tried to teach them exactly how to do business to-day. He has tried to teach them the prices of material, the price of labor and just how to manage it, and the young men go out thinking they know all about it. Now these are the changeable things. They do not last. I have observed that when a student has been taught the permanent things he has said very properly to a prospective employer, "I don't know how you manage your business, nor the details of your shop, I am here and ready to learn." The open mind is as important as the trained mind.

The world is coming to estimate rightly the man who can think and solve a problem, which has never been solved before, by the application of the everlasting principles of the materials and forces of nature and humanity. It ranks him higher and higher in the social scale. Last year it gave a high degree of honor to a civil engineer, an honor and a degree which I do not think they ever gave before. There was a man that could think, and all through the country they are now consulting engineers who, if they understand general principles and laws, can apply themselves to new problems.

Professor B. L. Newkirk: This matter of the conceit of the new graduates lies a good deal deeper than any training which we give them. Whenever this matter comes up I am reminded of a conversation in which I took part something over fifteen years ago. I was serving as an undergraduate assistant to an officer of the state. There were one or two other assistants in the same office. His method of training was sometimes vigorous, almost harsh. It happened that one of the

other assistants had offended at a particular time, and I was getting the benefit of the consequent vexation, because the other man did not happen to be present. My employer said, "I never had an assistant whom I did not have to cuff the conceit out of." Well, I didn't know just what to say, but I asked him if he had never tried to get assistants who were not conceited. "No," he replied, "I don't want them, they are not worth the powder to blow them up." It seems to me that in the very nature of humanity the young fellows are conceited, and I don't know but that it is a good thing. It is one step in their progress and if employers were to employ young men who were not conceited, they would come to the same conclusion as did this man, that such are not the kind of fellows they want.

There is another phase to this question. At a meeting of this society held in New York a few years ago Mr. F. W. Taylor said that there was a feeling that the larger companies which took in the young graduates as apprentices were exploiting them. I have talked with many of our young men and find that the companies, large and small, want to take them in for, say, fifteen cents an hour for an apprenticeship course. When you inquire what education it is proposed to give them, how they are to be transferred from one branch to another, and what is to be offered to keep them, the answer is discouraging. Thus the young man when he goes out has to be in a state of mind to enable him to defend himself from the people who are glad to get his services for a very moderate compensation.

Professor P. F. Walker: I feel that this matter of coöperation is an extremely important one and that we who are in the teaching work need the coöperation of the industries. On the other hand the industries also can well afford to secure real coöperation. In my course in mechanical engineering we have required that, during the summer vacation usually before the junior year, the students shall get perhaps two months of practical experience. We insist that the men go out into commercial work rather than work in our own shops. There has

not been a single student for whom we could not find commercial work, although it has not always been the line of work best adapted to them. I was disappointed this spring in receiving a reply from one of our large concerns, which a few years ago took two of our juniors, stating that they had given up the practice of taking men before they had graduated on account of the difficulty experienced in giving them proper work and arranging afterwards for doing anything with them. I was not asking that this concern should take any men with any assurance for the future but they seemed to feel that there was difficulty in taking men on for a few months. I believe that the industries can well afford to sacrifice a little in this direction. I know that we sometimes run against difficulty resulting from the control exercised by the unions, but at the same time there are not very many plants and industries which are not hampered in this way. I believe that there is a real way in which the industries can coöperate with the schools in helping out by furnishing work and thus really giving the men something as a basis for thinking.

I was very much impressed with what has been said regarding teaching students to think. There is nothing better for this purpose than the experience gained in actual work. Then when the men come back and go into other more advanced work, they have the viewpoint which they obtained outside. This serves to stimulate their thought and to greatly enlarge their mental horizon.

Dean F. L. Bishop: This matter of conceit really does exist, but it probably is greatly magnified. During the past few months I ran across two cases which are of sufficient interest to recount. One man was a graduate from a famous institution in the East who was assigned some very good work. When it came time to change him, as he had done so well, it was suggested that he go to a certain department and do some special outside reading under the direction of the young man in charge of the department and that he then work into that department. He asked: "Where did the man who is at the head of that department graduate?" The chief engineer said,

"From Cornell, why?" "Well," he said, "You don't suppose that a Cornell graduate can teach me anything, do you?" That story has circulated through the works ever since and everyone who knows about the conceit of this one man contends that this is what you may expect from a college graduate. The other case was this. A young man, who had received very high honors in his institution, was taken on in a shop with the idea that he would develop much faster than some of the others. He was assigned a certain piece of work with the expectation that he would stay on it at least three months, as it was the first time he had ever worked. At the end of two weeks he came back to the head of the department and asked him if he might be changed, that he thought he had learned all there was about that work. And the head of the department said, "All right, we will change you. To what department do you want to go?" On his replying he was sent to the desired department but returned in about ten days having learned everything there and desiring to be changed again. This was repeated until finally the chief engineer got tired of the process and gave instructions that the young man should be kept in one department at least six months. Not liking this treatment the apprentice finally took the matter over the heads of his immediate superiors to the vice-president of the company, thus antagonizing those who could have helped him most. As a result he has made very poor progress largely on account of his mental attitude toward his work.

Mr. A. T. Baldwin: I am particularly interested in the problem of education because I have four or five children growing up and I am naturally after an education for my boys in the best universities in the country. The problem of education has appealed to me from the point-of-view of manufacturing. From the manufacturer's point-of-view do you not take the raw material in the shape of boys who have graduated from the high schools, and endeavor to give them the greatest amount of theory in the shortest possible time? Should not the educator do what the manufacturer is doing at the present time? The latter expects more from his gas engines, his

boilers, his machine tools and he gets it. Can't we get more out of the human engine than we are getting, in a shorter space of time? I believe it is proper to endeavor to do that. It seems to me the right direction in which to work is in the line of putting more energy and better work into a shorter period of time upon our raw material. We cannot always select this raw material, but the college will naturally get the best results when it can select its raw material.

While I do not believe that a student should be conceited, he can have confidence in himself. The most successful men in the country today are the ones who have confidence in their own ability. They have not the "big-head," conceit, but they do have self-confidence and I would have the educators of the country encourage this spirit in their students.

Mr. J. W. Dietz: As a representative of a large employer of college men I take pleasure in telling something of an organized effort to give college graduates an opportunity to learn thoroughly the fundamentals of our business. Each year the vice-president appoints an educational committee made up of six men representing the three main branches of the business, that is, the commercial, the engineering and the manufacturing branches. The committee members at this time in the manufacturing branch happen to be the superintendents of our two largest plants, in one of which telephone apparatus is manufactured and in the other, the electric cables. The two men representing the commercial side of the work are our sales manager at Chicago and our telephone sales manager at New York. From the engineering department, the assistant chief engineer and the chief equipment engineer are members of the committee. The committee meets regularly and, as an advisory committee, directs the organization of the educational courses. The manager of the educational department is responsible to the head of the committee and, therefore, directly to the vice-president. The educational department's work has the prime object of giving a broad fundamental training for our business.

The training work is accomplished in three broad ways.

First, the students are given an opportunity for careful and systematic observation which is definitely scheduled under the advisement of this committee and the manager of the educational department. Assignments for this purpose include the entire organization, as many as thirty-five different departments being covered in one year's work. The second method of instruction is by actual practice, in no sense in an effort to get productive work from the men at a low rate of wages. Carefully-prepared statistics have been kept for a number of years and we find from the actual figures that the men are not able to earn the full salary which is paid them. The condition in which we wish to have them is that of a sponge, simply to absorb by observing processes. We believe, however, that it is well worth while for them to get the actual practice and contact with the workmen, hence we value this second part of the work.

The third method of instruction is by means of class-room and lecture work. The men are required to make definite, formal reports of the work done in their departments, and these are turned in each week, showing what has been done each day. Each man is thus taught to value his own time and the company's time. During the entire educational period, the department heads and others give lectures on their specialties, which the men are required to attend. These are given in the company's time and, therefore, no sacrifice of time or earnings on the part of the men is required. This policy we find to be amply justified in a business of the extent of ours.

Our company believes in college inspection trips. During the past twelve months more than four hundred college men have visited our plant in connection with these trips. We have tried to coöperate in a definitely systematic way, and to give our visitors intelligent, trained guides who can answer their questions. We want the visitors to have ample time to see the work thoroughly. We try to coöperate with educational institutions also through the visits of our representatives to the various colleges to give first-hand information as to the nature of our business and in an effort to enable stu-

dents to decide intelligently as to whether or not our work is such as to interest them permanently after graduation. We also believe in summer employment. I have a bit of testimony from a non-college man who employs a great many people in installation work. He told me just a few days ago that his foremen, whose work has to do with the installation of telephone exchanges, are glad to have college men come with them for the summer. He says it is somewhat of a handicap to have the men leave so soon but his attitude is evident from the fact that he employed last summer fifty or more men.

I believe that the educational committee realizes that the college men, by having this broad foundation period of training in our business, are much more able to adapt themselves promptly to their special assignments on the completion of the work. I have endeavored to outline the definitely-organized way which has been developed for coöperating with the college men who are entering the employ of the Western Electric Co.

Director W. B. Russell: I agree with Mr. Lee's conclusion. It would appear from the paper and from the discussion that the success or failure of the technical graduate is largely dependent on his particular viewpoint, and on his state of mind. Just here is where the technical-school professor can have a decided and immediate influence. I once ran across a graduate of one of the technical schools who after being six months with one of the railroads in the locomotive department thought that all of the locomotives should be re-designed and he was perfectly frank to tell everybody so. He was as bright a fellow as I have met and undoubtedly he is making good somewhere by this time. It was a matter of viewpoint entirely.

Then, again, there is a danger which this paper has brought out, namely that we may be a little too efficient in our engineering education. It is a fine thing to be an engineer, and if we tell the student this too forcibly he will think that engineering is all there is to life. The result is, perhaps, that he becomes a mechanical engineer for a railroad, getting perhaps four or five thousand dollars salary, while the superintendent of motive power over him, who is not a mechanical

engineer and who has not nearly his ability, is getting perhaps twice that salary. The engineer is so in love with engineering that he fails to see the opportunity to get the bigger job with more influence and more pay.

Dean C. H. Crouch: I am pleased to note the change in attitude on the part of the large industries toward the technical graduates during the past twenty or twenty-five years. I feel, however, that the colleges cannot give all of the training that these companies want. It is quite necessary I believe for the men to rub elbows with the mechanics and laboring men before they can be competent to be placed over other men and become successful superintendents. In the shops they get a training that we cannot give in the colleges, except in a partial way. There is no way that I know of by which our schools can give the training that the industries can give in that line. Men come into contact with various phases of human nature in commercial plants and I believe manufacturing industries have excellent facilities for taking out the conceit about which we have heard so much, if they only know how to do it.

I was impressed by a statement made by one who employs a large number of technical graduates in response to my inquiry as to the points in which our graduates are deficient. He said that their deficiencies result not from lack of technical training but rather from an unwillingness to work and to do menial things. Hence one of the first things he had to do with them was to "take the conceit out of them." There will always be the exceptional student who is somewhat conceited, but there is no difficulty in taking the conceit out of him, and after that he is likely to be a valuable man.

Mr. Lee: I have been very much edified by the remarks that have been made and can multiply instances to corroborate the points brought out. The Pennsylvania Railroad has had to do with many men who thought at the outset that they could tell us how to run a railroad. Every freeborn American thinks that there are two things which he knows how to do very much better than they are being done by the people who do them. One of them is how to run a newspaper and the other

is how to run a railroad. This is particularly the case with your college graduates who are taking special work in transportation. An instance that comes to my mind was in connection with a Harvard man. Harvard has a graduate school of business administration in which they have some very interesting and elaborate courses in transportation, very well conducted indeed. One of our vice-presidents made an address at Harvard a few years ago in which he told of the demands of the railroads for college men. He told the class of the practice of the Pennsylvania Railroad of not taking any man into its service in what we may call the rank of commissioned officer, or in line for promotion to that rank, who is not a college graduate. Of course when he went back to work he got a great many applications for jobs. These were sifted over, as the opportunities were limited, and we picked out the man whom we thought would make good in the traffic department, that is, in the solicitation and handling of freight traffic. He was assigned to work on one of the piers in New York, the plan being to make him familiar with the rates, to put him into close contact with the public, to make him actually receive the freight from the draymen, to way bill the freight and to see that it got started on its journey to the consignee properly. This man was to work at the job for about six months and we were going to put him at something else. After he worked there about three weeks he wrote a letter to the vice-president, disregarding his immediate employer, and advised him that he was thoroughly familiar with this work and would now like to be considered an applicant for the position of assistant to one of the vice-presidents. Obviously he did not "last long" with the Pennsylvania Railroad. While I sympathize with the viewpoint of the gentlemen who believed in inculcating confidence, yet confidence in one's fundamental ability is different from having confidence in the fact that your technical adaptation of that ability makes you competent to go ahead and tell other people how to run their business.